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A REPORT TO INDUSTRY

OUR PRODUCT: TRAINED MANPOWER

A total of 767 undergraduate engineering students received their degrees during the year 1959-60. This period included the summer of 1959 (125), the semester ending in February 1960 (265), and the semester ending in June 1960 (377). Of this total, 437 were employed by industry at an average starting salary of slightly over $525 per month.

Of the 330 remaining students, 64 entered the armed services and 142 went into graduate schooling. The other 124 were foreign students who were returning to their countries, men who were on leave of absence from industry to further their educations, people who were graduating in absentia, and a handful of graduates who still hadn't accepted jobs.

During the 1959-60 year, 651 companies conducted 11,182 interviews on the campus. Starting salary offers showed a continued upward trend during the period, averaging $514.89 in August 1959, $529.75 in February 1960, and $531.82 in June 1960. These salaries were based on a 40-hour work week. The industries which took most of the graduates were electronic, radio, and television; aircraft and missile; light manufacturing; heavy manufacturing; county, state, and federal governments; and basic metal industries. These industries hired over 75% of the graduates who were employed during the year.

Trends seem to be toward more company visits to the campus, more interviews of prospective graduates, higher starting salaries, extremely heavy demands for electrical engineers, mechanical engineers, physicists, and mathematicians, and more demands for advanced degree holders. The growing demand for engineers with graduate degrees is accompanied by the increasing number of students who are entering graduate school.

MACHINES CAN'T SAY "MAYBE"

How well can a man and a computer work together? The University's Coordinated Science Laboratory recently completed a series of experiments involving such a partnership — and found some interesting answers.

The research, sponsored by the Army, the Navy, and the Air Force, was designed to test the capabilities of automatic and partially-automatic air defense systems during a series of simulated high-speed bombing raids. In the dispatching of interceptors, "human" decisions were made by an experienced naval officer and automatic decisions were made by the ILLIAC high-speed digital computer. Three systems were evaluated: an automatic system programmed to run without human intervention; an automatic system in which the officer could override the computer decisions at any time; and a manual system in which the computer did only routine vectoring of interceptors.

Although the pre-experiment hypothesis was that the man would tend to become overloaded with data when confronted by heavy raids and that the same number of targets would not degrade the performance of an automatic system, this did not prove to be true. Under heavy attacks the more automatic systems, although not overloaded, allowed more bombing target penetrations and accomplished fewer defensive kills than did the manual system. This happened because the man did *not* become overloaded and was able to perform much better than was predicted.

The man and the computer did not work well together when the machine was given any significant part in the decision-making. For one thing, the man learned through experience; the computer did not. For another, the man could often anticipate the "enemy's" moves; the computer could not. The man could make decisions on the basis of patterns or groups of attackers; the computer was programmed to treat each object separately.

Probably the most interesting conclusion is that the man is far more flexible than the machine. Compared to a computer, a man's ability to make absolute decisions and do fast computations is relatively poor. But in answer to the question of whether or not he could intercept before a raid reached the target, he could gamble in some circumstances and answer "maybe"; the machine could only answer "yes" or "no." Thus the man might attempt an interception, sometimes with successful results, which initially appeared to be so unlikely that the computer would not even try.

Man's ability to weigh odds and to gamble gives him at present an advantage over the computer in this sort of test. Computers of the future will have to have the word "maybe" added to their vocabularies.

CIVIL ENGINEERING — THE OLD AND THE NEW

Civil engineering has changed since 1893, when Civil Engineering Hall was built at the University of Illinois. The old fireplaces and chimneys, the sculptured wooden staircases, the creaking wooden floors of the building have memories of the days when power was supplied by mules, men, and noisy steam engines, when roads had to be passable for wagons and the maximum speed was that of a fast horse. The memories are there, because Civil Engineering Hall is still the main building of the Department of Civil Engineering.

The faculty and students using the building, however, are more interested in the present and the future. They are using C. E. Hall not as a museum but as a place to learn the latest and best of a dynamic and progressive field of engineering.

Of course, Civil Engineering has space in several other buildings, too: 2 old houses, 2 Quonset huts, 1 converted house, one end of a temporary wooden shed, and "borrowed" space in Talbot Laboratory and the old surveying building. The only permanent structure the Department has all to itself is a small brick building used by the sanitary engineers.

Is this to be the Civil Engineering Department's only cornerstone for the future? Illinois voters will decide in the Universities Bond Issue election in November.

This space houses the largest daytime undergraduate enrollment in civil engineering in the country and the largest civil engineering graduate enrollment anywhere. Last year Civil Engineering had 612 undergraduate students and 245 graduate students. More are expected this year.

Twelve years ago, the Department requested a new building to meet expected development. No new building was built, and both undergraduate and graduate enrollment have more than doubled. They are asking for the same amount of space right now, to meet present needs.

Quantity is important to help meet the nation's growing need for civil engineers, but numbers alone are not the goal. The quality of the education given to our future civil engineers is of primary importance. The Civil Engineering Department has long been recognized as one of the best, and many members of the faculty are outstanding authorities in their specialties. A recent indication of quality at the undergraduate level came from the performance of nine students who participated in a National Science Foundation undergraduate research program. Of the nine projects, one won a national award in photogrammetry and three others have either been published or are awaiting publication in professional journals.

The lack of space has kept the Department from moving into new fields as rapidly as it should. The photogrammetry program, for example, is using a curtained-off portion of a classroom for its laboratory. New work should be started in air pollution and waste disposal, including radioactive wastes, but these subjects can't be fully developed without laboratory space, and there is none available. Highly significant work on structural dynamics, important in such matters as satellite and bomb shelter design, is handicapped by insufficient space. New developments in such other important areas as soil mechanics, hydraulics, and highways are hampered seriously for want of adequate facilities.

No figures on the demand for civil engineering graduates are available from the College's Placement Office — paradoxically because the demand is so great. Most of the recipients of graduate degrees are hired before they get to the Placement Office for interviews.

How well the Department of Civil Engineering will be able to do its job in the next few years depends to a considerable extent on the outcome of the Universities Bond Issue election next November 8. If the Universities Bond Issue is passed by the voters of Illinois, the State Assembly will have funds available from which the cost of adequate facilities for training civil engineers may be appropriated. The Department of Civil Engineering at the University of Illinois can and will maintain its tradition of excellence, if it has adequate facilities. The Department can better teach twentieth century engineering if it is not restricted to a nineteenth century building.

NUCLEAR REACTOR BEGINS OPERATION

Experts predict that in the next 100 years we will need ten times more energy than the world's remaining fossil fuels can supply. This does not mean that the world's conventional fuel resources will be completely exhausted by 1970 since the rate of usage will increase more than tenfold during the next century. It does indicate the urgent need for fundamental research which will lead the efficient and widespread use of nuclear power facilities. Such research at the University of Illinois was given a big boost in August when the ILLINOIS TRIGA (educational and research) nuclear reactor was put into operation.

The ILLINOIS TRIGA was designed and constructed by General Atomic, a division of the General Dynamics Corporation. It is not designed to produce useful power but is a training and research reactor which operates at temperatures close to ordinary room temperature. It is licensed by the AEC for operation at 100 thermal kilowatts. With minor changes in shielding and cooling, the reactor is capable of much higher power levels.

This is the first above-ground reactor in the United States to use uranium-zirconium-hydride fuel. There are only 4½ pounds of U-235 in this fuel element, but it will generate power equivalent to the average electrical usage of 50 houses — and it will do so for 10 years!

Such fuel elements have the highly desirable property of limiting the reactivity of the reactor during sudden temperature increases. Thus, in addition to all the usual safety devices of control rods and monitoring, a TRIGA reactor is automatically self-limiting and self-protecting under any conceivable power excursion, so that completely safe operation is possible within convenient distance of other campus buildings.

Added safeguards for the ILLINOIS TRIGA are a windowless laboratory building and control of exhaust air. Though accessible, all beam ports are below outside ground level to avoid stray radiation.

The reactor tank, filled with purified water, is 6½ feet in diameter, 21 feet tall. During operation, fuel elements are visible from above. An adjacent 9 x 12 pool, also water protected, gives direct observation for radiation shielding studies. Four access ports through 7½ feet of concrete allow beams of neutrons from the core to be used for experiments located outside the reactor shield.

The reactor will be used not only for student training and graduate student thesis research, but also as a major research facility on campus. It will serve the state and the nation by supplying trained manpower through the advanced degree program in nuclear engineering. In addition, through its use in other courses and in "short courses," people in other fields will be trained in the handling of radioactivity, in isotope applications, and in tracer analysis of materials.

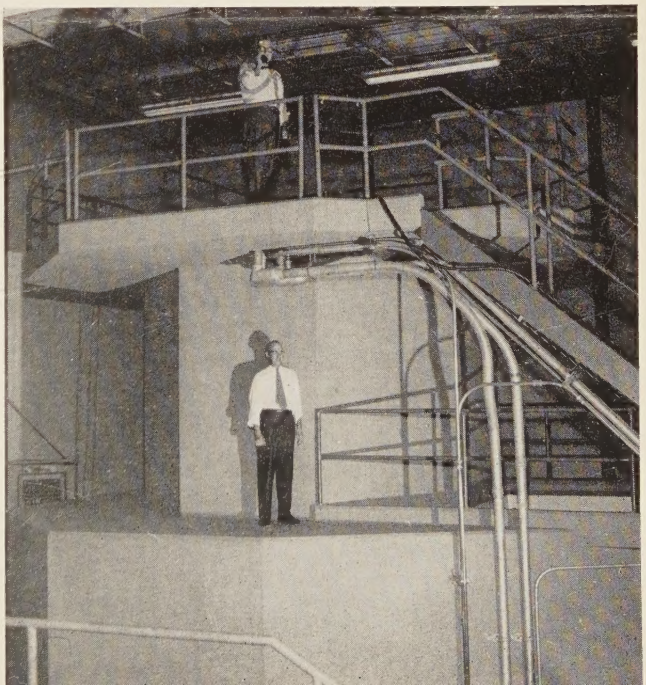
Results of research done with reactors like the ILLINOIS TRIGA will contribute to the development of nuclear fission power facilities, which will extend our energy-producing capabilities by another 100 years. Such fundamental efforts will also be instrumental in the development of the next step: the controlled thermonuclear fusion reaction, which will give us a cheap and nearly limitless supply of energy. It would not be an exaggeration to say that man's future depends upon this development.

Policies of the Nuclear Engineering Program are guided by an inter-departmental committee under the chairmanship of Professor Ross J. Martin. The members of this committee represent the interests of the various departments concerned and will be responsible for courses of instruction in reactor theory, design, and laboratory practice.

JOHNNY CAN'T DO MATH PROBLEMS EITHER

It seems quite probable that the well-known Johnny who couldn't read couldn't handle computations very well

Inside the University of Illinois nuclear reactor building Prof. Marvin Wyman (center) stands 12 feet above the reactor floor on the main concrete shield of the ILLINOIS TRIGA core. Prof. Ross J. Martin (top) stands on the platform from which fuel elements in operation may be observed. Prof. Martin heads the University interdepartmental nuclear engineering program; Prof. Wyman is chairman of the committee responsible for use of ILLINOIS TRIGA.



either — and for the same reason: the way he had been taught. In neither subject was he encouraged to think for himself. Instead he was filled with rules which often had little to do with reading or mathematics and which caused him to dislike both subjects. In other words, he wasn't primed; he was flooded.

Since 1952, the University of Illinois Committee on School Mathematics (UICSM), directed by Professor Max Beberman, has been working to develop a new curriculum for secondary schools. The UICSM is a joint committee of the Colleges of Education, Engineering, and Liberal Arts and Sciences.

The UICSM project seeks to remove the useless verbiage from the teaching of mathematics and replace it with encouragement to think creatively. To do this, members of the committee asked themselves such basic questions as: "What is a number?" "What is a variable?" What is an abstraction?" In answer to the last question, for example, they decided that *a* or *2* or a whole equation is *not* an abstraction. An abstraction is an entity which has no physical existence. The letter or numeral is simply a "concrete" instance of the abstraction to which it refers.

After defining such fundamental terms, the committee realized that most secondary school students (and some of their teachers) do not really understand the basic concepts of mathematics. The students were memorizing rules which they didn't understand to apply to concepts which they didn't understand either. The committee concluded that if Johnny could be made aware of mathematical abstractions before he began to manipulate the symbols which denoted them, he might be able to make sense out of the rules and discover some short-cuts for himself. If so, he would like mathematics and would do well in it.

With these principles in mind, the committee members started writing instruction materials, developing teaching methods, and training teachers for the new curriculum. Eight years of work have reinforced the beliefs of the people involved; and in July 1956 the Carnegie Corporation made the first bequest to the project of a grant that has since totaled more than a half-million dollars.

This year (1960-61) 120 schools across the nation are trying the UICSM program, and the eighth version of the instructional materials for the beginning course has been published. Through the Teacher Associateship program, each year 5 or 6 teachers spend a year working and studying in Urbana. In addition, summer workshops, personal consultations, and week-end conferences take place through the project center at 1208 West Springfield, Urbana.

Whether we are interested in Johnny as a son, a future engineer, a potential teacher, or just for his own sake, we may be certain of one thing: if he learns to read, write, *or* compute, it will not be because he has worked tediously with recipes. It will be because he has worked enthusiastically with ideas. That is what the UICSM project is trying to promote.

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